A. M. D. G.

BULLETIN

of the

AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

(Eastern Section)

(For private circulation)

Vol. II, No. 5. Weston, Mass. May-June, 1925. p. 57.

PHOTOGRAPHIC NOTES. I. THE DARK ROOM.

These notes are intended to give practical help to our teachers of science (astronomy, physics, chemistry, geology and biology) in the making of lantern slides for class work. History and literature classes may be aided also by screen illustrations.

In the old days of the albumin and collodion processes a poor slide was a rarity. Nowadays, helped by the ready-made lantern plate, commercial quantity production has pushed quality from the first place and good slides, that is, clean, clear and sharp, with detail showing in the shadows, -- slides decent looking and well dressed are being hopelessly outnumbered by the mob of mediocre individuals let loose by most commercial firms. Excellent slides can be made by our own teachers and they will cost no more in money than poor slides. If screen illustrations are worth making at all, they are worth making well. The prospective slide photographer must understand thoroughly the festina lente, must have patience, a memory of past errors and their causes, "a firm purpose of amendment", and must be willing to give each slide individual attention in order to insure best results. Since these notes are to be practical, fulness of detail will not be out of place.

Dark Room: location. The dark room must, of course, be near the exposure room, and the position of this latter should, in our opinion, be determined by the class of work to be copied. Besides diagrams and prints of various kinds, (all flat work) our camera subjects may include "natural objects", lifeless, dead and living. Flat work can be taken satisfactorily in artificial light, but "reliefs", for simple, strong, natural appearance with proper shadows, require daylight (diffuse) illumination. So do not put your exposure room or dark room in a cellar.

Dark Room: fittings. The room need not be large, ten feet square would be ample; it should have a window or skylight for "spasmodic" ventilation; its walls and ceiling should be of a flat maroon color so that white-light leaks may be toned down to harmlessness after reflection. There should be shelves for chemicals and apparatus, a closet for unexposed plate stocks, a developing table with a stool (not a chair), and a sink (running water) large enough to accomodate two 10" x 12" trays, with a tap over each tray. The developing table should have on it a large piece (2' x 3') of heavy, ribbed, skylight glass, with wooded strips fitted to three sides, one side (short) being left free for cleaning, etc. There should be three electric lights,-- a 40 W., white, for the room, hung high; a 25 W., ruby (not

dipped, but real red glass) over the sink, and another 25 W. ruby in a desk lamp holder, flexible goose neck with a clam shell shade. This latter is the developing light and may be turned as to throw as much or as little light as is desired on the plate tray, with no glare in the eye to interfere with the detection of slight changes in the developing plate. And by all means remember to have near the sink a generous roller towel.

Dark Room: apparatus and chemicals. Theoretically the chemical supply department might take care of the photo room, but in practise much friction (lost work) will be avoided if the dark room has its own equipment

Balance: an ordinary small balance, low type, weighing up to two ounces. Most photo formulas are now printed in both English and French systems of weights and measures. If we say that 15.5 grains = 1 gram, and 28.5 grams = 1 ounce (avoir.), and 30 cc. = 1 fluid ounce, the errors will have no effect.

Trays: we shall suppose the camera capacity to be 8" x 10"; in most cases 4" x 5" or 5" x 7" would be the upper limit. There should be two 8" x 10" glass trays, with ridges on the bottom inside (to prevent adhesion of plates), one tray for developing and one for "fixing". Each one of these should rest in a 10" x 12" enamelled iron slop tray for the sake of cleanliness. For smaller plates economy of developer demands one 5" x 7" and one 4" x 5", both of glass. Try to buy trays with sides at right angles to the bottom (less spilling when rocked). There is no use for smaller trays. There should be another enamelled tray, 8" x 10" at least, for washing plates (six 3 1/4" x 4 1/4", or four 4" x 5" at once). For 8" x 10" plates a washing box is needed if more than one or two are to be treated at a time.

Measuring glasses: two will be needed, one 8 oz. and one 4 oz., graduated in drams (or cc.). Do not buy cheap glasses with moulded graduations; they are not accurate. For a developer pourer use a large tumbler or 10 oz. jelly glass, something solid and substantial. Always empty and wash out graduates after using.

Printing frames: for slide making by contact, one 4" x 5", one 5" x 7", and one 8" x 10"; these are to be fitted with snug pieces of clear, flawless, flat glass (double thickness for the 8" x 10"). Do not buy anything smaller than 4" x 5", even for very small films.

Chemicals: Hypo-- sold in kegs (150 lbs.), bags (100 lbs.), pails (25 lbs.)--much cheaper in these quantities than by the single pound; false economy to "skimp" the hypo.

Alum (potash), powdered, 1 lb.
Acetic acid, 50 per cent, 1 lb.
Potassium ferricyanide, 1 oz.
Hydroquinone, 1/4 lb. carton---costs nearly double by the single ounce.
Sodium hydroxide, stick, 1 lb.
Sodium sulphite, dry, 1 lb.
Sulfuric acid, concentrated, C.P., 1 lb.
Potassium bromide, powdered, 1 lb.
Ammonium persulfate, 1/4 lb.
Mercury bichloride, 1/2 lb.
Ammonium hydroxide, concentrated, 1 lb.
Precipitated chalk, 2 lbs.
1 oz. of methyl orange or tropoelin orange. (Do not take the "home made" variety of methyl orange from

the chem. lab., or you may ruin a good negative.
1 cake of Gihon's Opaque. It costs .50 cts. and will last three or four years.
Some used tooth brushes, not too old.
Two or three ordinary camel hair brushes, wooded handles, medium size, for use with the opaque in "blocking out" and with the dyes in staining.
One thing more and the dark room will be fairly well equipped: some kind of glass cutter is needed,-- a diamond, or a steel cutter with replaceable wheels.

The plate supplies, sizes and speeds will be treated in our next issue.

Father J.A.S. Brosnan.

SIMPLE EXPERIMENTS WITH A RADIOTRON.

The three electrode vacuum tube is not only one of the essential elements in radio transmission and reception and in long distance wire telephony but it is also an instrument possessing properties of great interest to the physicist. Moreover, its applications in other departments of physics and even in other sciences suchas astronomy and biology are becoming of increasing importance. It would seem, therefore, to merit a permanent place in our college lecture and laboratory courses of physics. Although our professors are using the tube in their class work and are familiar with it, the following notes describing some of the simple experiments which can be performed with it are given here in the hope that they may be of some use to our readers. The general theory can be found discussed at length in the standard texts, such as Van Der Bijl, "The Thermionic Vacuum Tube", McGraw-Hill Book Co.; "Radio Engineering Principles", McGraw-Hill Book Bo.; and Morecroft, "Principles of Radio Communication", J. Wiley and Sons, etc.

The beginnings of the tube, as is well known, go back over forty years ago when our veteran inventor Thomas A. Edison was developing his incandescent lamp. In the course of his experiments he inserted a metal plate in the bulb near the filament. This plate was connected in series with a galvanometer with a terminal of the filament. A deflection was noticed when the filament was heated, its magnitude increasing as the temperature of the latter was increased. This indicated a current flowing across the vacuum from the plate to the filament. There was no satisfactory theory at the time to account for the phenomenon nor did any one dream of any practical applications. On account of other more pressing work Edison did not continue his experiments along these lines. In the early years of the present century an English physicist, O.W. Richardson, made an extensive study of the whole subject. (Cf. his monograph, "The Emission of Electricity from Hot Bodies", Longmans, Greene and Co., 1916.

We may recall that according to the electrom theory some of the electrons belonging to the atoms of a conductor move with comparative freedom from one atom to another, so that at any given moment there are a certain number of free electrons in the metal. Atoms and electrons are in a continual state of vibration which becomes more vigorous as the temperature of the metal is raised. The electrons, on account of their smaller mass, will have the greater velocities and will tend to escape. A surface force akin to surface tension opposes this. A temperature may finally be reached at which some of the electrons acquire sufficient velocity to escape, very much as molecules es-

cape from an evaporating liquid. According to Morecroft this velocity in the case of tungsten must be at least 10^8 cms. per second. The electrons which escape carry their negative charges with them and leave the conductors positively charged. They are consequently attracted back to it, so that in the case of a wire conductor in a vacuum tube a state is reached in which as many electrons return as escape. This electron emission depends not only upon the temperature of the wire but also upon impurities in the metal of which it is made and upon the nature of the surface. The electrons may be made to pass to a plate near the wire thus producing the so-called plate current.

The Radiotron is the common form of the tube making use of the electron emission from a hot wire. Any type employed in radio may be used in the following experiments. A standard socket should be mounted upon a board with its four terminals connected with suitably arranged binding posts. A fifth binding post may be added, connected with the negative terminal of the filament to serve as the second terminal of the plate circuit. A tube rheostat is mounted on the board and inserted in the filament circuit. The plate current and its variations can perhaps be shown best to a class by using a suspended coil galvanometer of the proper sensitivity in the plate circuit and reflecting a beam of light from its mirror upon a screen or a wall. Any device for furnishing a parallel bright beam might be used. The Cenco Arc Illuminator made by the Central Scientific Co. of Chicago is quite convenient. It can easily be mounted on a rod support in any position. A beam of sunlight may also be used.

Experiment I. To indicate the presence of free electrons above a hot wire. This may serve as an introductory experiment. It is briefly described in the "Zeitschrift für den physikalischen und chemischen Unterricht", July-September, 1924, page 193. A radiotron could be used but it is simpler and more striking to use an ordinary Mazda lamp. A strip of tin foil about 1 1/2 cms. wide is wrapped around the middle of the bulb and connected by means of a wire to the plate of a gold leaf electroscope. The latter is set up in the usual way between the condensers and objective of a stereopticon and the leaves are focussed upon the screen. When the lamp is cold the leaves of the electroscope under favorable conditions will remain diverged whether they are charged positively or negatively. Suppose now that the leaves are charged positively with the lamp cold. As soon as the lamp is lighted the leaves will collapse. The lamp is then turned out. The operator then charges the leaves negatively. Upon lighting the lamp they remain unchanged. In the latter case the free electrons about the hot filament and those constituting the negative charge on the electroscope repel each other. The leaves consequently retain their charge and remain diverged. In the former case the positive charge is attracted by the free electrons and is bound by them.

Experiment II. To show the Edison Effect. For an account of the Effect and of Edison's work cf. an article by C.H. Sharp, on "The Edison Effect and Its Modern Applications", in the JOURNAL OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS for Jan. 1922, page 68. This article quotes Edison's own description of his discovery. In his patent of Nov. 15, 1883, Edison says, "I have discovered that if a condicting substance is interposed anywhere in the vacuous space within the globe of an incandescent lamp and said substance is connected outside of the lamp with one terminal, preferably the positive one of the incandescent conductor, a portion of the current will, when the lamp

is in operation, pass through the shunt circuit thus formed which shunt includes a portion of the vacuous space within the lamp. This current I have found to be proportional to the degree of incandescence of the conductor or candle power of the lamp." As will be observed no mention is made of any battery in this shunt circuit.

To demonstrate this plate current as Edison did, a fairly sensitive galvanometer such as the Type P Leeds and Northrup instrument may be used. It is set up and a beam of light is reflected from its mirror to the screen. It is connected in series with the plate and one terminal of the filament of the Radiotron. There will be a deflection only when the filament is hot. It will increase as the filament temperature is increased. As the Radiotron has a very high vacuum the current is due entirely to the electrons emitted from the filament, their velocity being so great that their inertia carries them across the space to the plate. In the article by Sharp referred to above, Edison is quoted as saying that he was able to operate a telegraph sounder with this plate current. He may have had a very large lamp but it would seem that in this case there was a small amount of residual gas in the tube and that this was ionized thus allowing a greater current to flow.

Experiment III. To show the effect of a positive potential upon the plate. The circuit is arranged as in Figure I. The filament F of the tube is connected with a battery A through the rheostat R_1. An ammeter AM may be inserted to measure the current. To give a varying potential to the plate a so-called voltage divider may be used. This is simply a sliding contact tubular rheostat R_2 of two or more thousand volts resistance. These rheostats of various sizes and resistances are sold by Biddle, and also by Beck Brothers, of Philadelphia. A 45 volt B battery B is connected across its terminals. The plate P of the tube is then connected to the positive terminal of the rheostat and the negative terminal of the filament is connected to the slider S. A voltmeter VM is also connected to the positive terminal of the rheostat and to the slider. By moving the slider along the coil of the rheostat any voltage can be tapped off and its magnitude measured by the voltmeter. G is a small, moderately sensitive suspended coil galvanometer. A beam of light is reflected as before from its mirror. When the filament of the tube is cold no current will flow in the plate circuit however great the voltage applied. When the filament is lighted, it will be noticed that as the positive plate voltage is gradually increased the galvanometer deflection increases, slowly at first, then more rapidly, and finally it remains unchanged. The filament current should be so adjusted that with the maximum plate current the light spot will remain upon the screen. If we start again with a little higher filament temperature, we get similar deflections but in this case the maximum deflection has a higher value. Evidently the positive plate attracts the electrons emitted by the filament. As the plate voltage increases more and more electrons are drawn over thus increasing the plate current. As over six billion billion electrons per second are required to furnish a current of one ampere it is evident that the current actually obtained will be quite small. The maximum or saturation value will be reached when all the available electrons are drawn to the plate. Increasing the plate voltage will have no further effect. A higher filament temperature will furnish more electrons and thus give a larger plate current for the same plate voltage. According to Richardson the saturation current is re-

presented by the equation $i = a\sqrt{T}.e.^{-b/T}$, where i is the current in amperes, T_1 is the absolute temperature of the filament, e is the base of the Naperian system of logarithims, and a and b are constants. For tungsten in a vacuum of less than 10^{-7}mm. of mercury Langmuir has found the following values: $a = 2.36 \times 10^7$, $b = 5.25 \times 10^4$. When T = 2000 the current i is equal to 0.0042 amperes per square centimeter of surface.

Experiment IV. To show the effect of a negative potential upon the plate. It is simply necessary to reverse the connections of the B battery on the rheostat in Figure I. With a hot filament there will be no deflection of the galvanometer however great the plate voltage. The plate now repels the electrons, the repulsion increasing as the plate voltage increases.

Experiment V. To show the effect of a varying filament current with a constant positive potential upon the plate. The circuit of Figure I is used. A convenient positive potential is put upon the plate. Starting with a cold filament and consequently no deflection, the filament temperature is gradually raised by increasing the current through it. The galvanometer deflection will increase as before and finally become stationary, indicating a saturation current. As the temperature of the filament is raised, more and more electrons are emitted. They crowd the space between it and the plate until finally the repulsion they exert on the electrons near the filament becomes in many cases greater than the attraction of the plate itself so that only those with higher velocities are able to get through. We thus have evidence of the presence of the negative space charge which limits the plate current in spite of the plate voltage. It has been studied by Langmuir and others.

(To be continued).

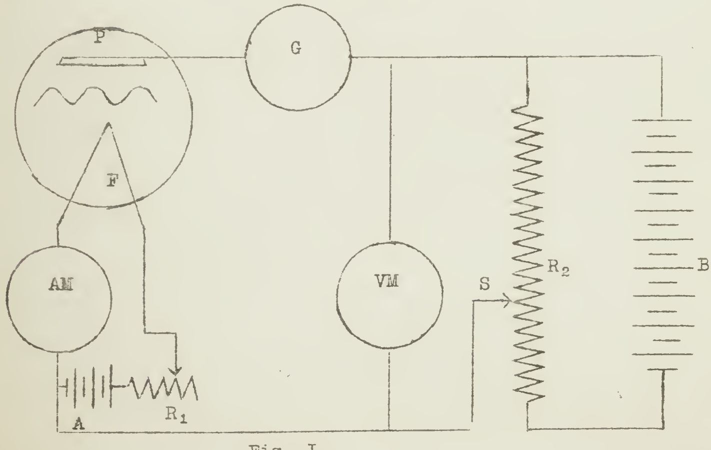

Fig. I.

Father H.M. Brock,
Weston, Mass.

The American Geophysical Union held its annual meeting at Washington on April 30 and May 1. The program was a very interesting one. Father Tondorf represented Georgetown University and read a paper which we give in this issue. Concerning the meeting he writes:-

"As I attended the meetings of the section in seismology and the general meeting only, I am not prepared to report on the other sections. The feature of the meeting on seismology was the interesting discussions that followed the reading of the papers as noted by title on the program. There is much enthusiasm along this line of work. As you probably know the United States Coast and Geodetic Survey has been authorized by Congress to take this line of work into the survey. Up to the present it was handled by the Weather Bureau. This has given a marked impetus to thework. At the general meeting Dr. Louis Bauer of the Magnetic Survey of the Carnegie Institution gave an illustrated lecture on the Meeting of the International Geophysical Union at Madrid last October. In many of the views shown one could recognize our Fathers of the Spanish Provinces. In conversation with the delegates of the Union to this meeting, Dr. Bauer of the Carnegie, Dr. W. Bowie of the Coast and Geodetic Survey, and Dr. Kimball of the Weather Bureau, I heard nothing but praise of the work that our Fathers in Spain are doing in the interest of science. I had quite a chat with McAdie, and he, too, spoke so nicely of the work of the Society. Before a gathering of some twenty he remarked that the Jesuit Fathers do not receive the credit that is due them."

ENHANCING THE VALUE OF THE SEISMOGRAM.

(Paper read at the meetings of the Geophysical Union, April 30, 1925.)

With no little interest I recall a visit made some few years ago in the company, amongst others, of Dr. Struve, then the director of the Pulkova observatory, to one of our lesser, perhaps better said, smaller astronomical observatories, and there meeting with the director whose apologies for the scanty equipment of his plant were more than profuse. The comment of the Russian astronomer on this occasion will ever remain with me. He remarked: It is not a small eye at a big telescope, but a big eye at a small telescope that makes for our knowledge of the heavens. Mutanda mutandis, this statement fits for all of the sciences, none assuredly more snugly than seismology. It is unquestionable that whatever advances are to be looked for in the very near future in seismology, geophysics, or geology generally, will for the most part be mediated through the instrumentality of the seismogram. The demand then for good grams, and above all the most reliable interpretations of the grams is unequivocably imperative. One of the members of this community, at the meeting of the Union last year, so I remember it, ventured the statement that it was his mind that the number of the seismic stations the country through was quite adequate. I do not recall that anyone challenged his contention. He might have added, I feel, that though the installations at these stations are not in every instance of a class "A" character, there is no reasonable doubt but that all of these could broadcast most valuable data. At least so it would seem if one admits with Struve that the machine does not make the observatory. Is such information being despatched from the centers? Of the twenty nine stations catalogued by Dr. Wood in the Bulletin of the National Research Council, Volume II, part 7, scarcely thirty per cent make any pretence at the issuance of regular

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reports. This proportion is, to say the least, intensely discouraging. Assuredly it is easy to enhance the value of these grams, assuming that the machines at these stations are in operation, by marketing the grams. Possibly the overseer~~e~~s of these stations are to be impressed with the "worth the while" proposition and a quick activity would be forthcoming.

Now to the stations issuing reports. What are their records showing? Fourteen years of persistent juggling with these scribblings of a fretful earth have convinced me that when Dr. Sieberg of Jena wrote that the deciphering of a seismogram was an art, he came indeed close to telling the whole truth. But the disappointment of it all to us is that neither he nor anyone else laying claim to skill in this art has handed us any clue to the mastery of this cunning. Evidently it remains then a clear case of "learning through erring". But who is to acquaint us of the error? Who isto show how we are to read out of a gram all that is in it? A one-man comparing of our grams with grams of other stations will hardly fetch us anywhere. Let me ask your indulgence for looking into this matter a bit more closely.

We all know that the first of the problems confronting the research worker in seismology is the geography of the earth tremors. Epicenters, you know, are best figured out from the times of arrival of the first and secondary preliminary waves. What have we been getting out of our grams toward establishing these areas? Let me appeal to a concrete case. I take the figures of my own station. The files show that in the past nine years we have registered 739 earthquakes, an average of 83 per annun. I note that I am considering registration as obtained from mechanically recording apparatus only. The inference then to what might be obtaining at other stations in the States is the more fair, since most of these stations are equipped with mechanically recording seismograms. Reading these 739 quakes along all components, i.e. N-S, E-W, and Z, I find that the first preliminary tremor was recognized in 556 instances. Of these P is listed in just 100 cases as appearing with a marked onset, i.e. with an impetus. This represents, therefore, 14 per cent of the total quakes recorded. P is catalogued as an emerging wave 376 times and as very questionable P in 80 instances. On the assumption that the most and probably only dependable reading is P with an onset, we have a very low basis (14 per cent) for the determination of the focal points of the disturbances. Nor are we to forget that in very many instances, possibly no less than thirty per cent of the cases, the reflected waves in P or $_iS$ are mistaken for $_iP$ and that so the above figures are strikingly lowered. P read as an emerging wave, gives the time for p too late. A comparison with photographic registrations unquestionably points to this. Where P is masked in microseisms the tendency prevails to anticipate the reading of P. At all events where the first tremors are of the nature of an emergence, P is ambiguous though probably not to the same extent as when noted as doubtful.

For S. Here it is to be noted that for distances in excess of 11,000 kilometers, the arrival of the secondary tremor is very difficult to ascertain. For the total number of quakes (739), the secondary was read as with an onset 94 times. This is in accord with what might be looked for since the incidence of S is less sharp than P. The average then for the appearance of S with an impetus is 11.4 per cent of the total, or two per cent below $_iP$. S was read as an emergence 75 times, and as doubtful in 191 instances. Total readings in S were ~~6~~ 360. This is low as compared with P but readily accoun-

ted for in that many of these registrations were from great distances.

Taking now $_iP$ with $_iS$ at their maximum appearance on our records for the determination of the epicenters, we touch the low limit of less than twelve per cent for all the quakes registered.

Where either p or s is entirely without the gram, the emerging wave in L may be substituted for p or s respectively for determining the epifocal point. Walker describes this wave as gradually increasing in amplitude over the p and s waves and looking as if it had been drawn with a shaking hand, thereupon a rapid development of extremely smooth waves of rather short period, reaching a maximum amplitude. Our day book shows that we were somewhat bolder in our attempt to fix this wave than in the case of the two antecedent waves. So we find $_eL$ noted 564 times and 144 times with a question mark. Very striking this and logically it is inferred that the error is proportionally great.

I am absolutely convinced that a critical study of the records of other stations in the States would not only run these low figures a close second but would be far below them. I remark this advisedly. For my numbers show the result of the comparative analysis of grams from three different instruments, a condition which is unique to my station. We must not, therefore, blind ourselves to the helplessness of a one-man interpretation. Nor should anyone nurse the notion that this is a reflection on our seismologists. Dr. Klotz pertinently remarked some years ago: "most of us had to grope our way into this subject without any personal aid or assistance or explanation about either instruments or seismograms".

Face to face with these emergencies, is there any salvaging these grams? I had felt at one time that much might be gained in reading our grams by an exchange, immediately upon the registration of quakes, of special bulletins giving the more important data for comparison. But time soon robbed me of any confidence in this scheme, the objection being that one is so unphilosophically prejudiced, now against, now in favor of the opinions of another. And after all this is but shifting the difficulty.

Many of us will recall that in 1917 Dr. Klotz, whose loss to science each of us lamented, was appointed chairman of a Scientific Committee of the Seismological Society of America, and that he published in the Bulletin of the aforesaid society that same year a series of Memoranda, bespeaking the findings of the Committee. In one of these entitled "Central Bureau" he attacks the problem under consideration. I shall read the memorandum in part. "We all want to improve, there is no exception. At present the International Seismological Association is unavailable. My idea of a Central Bureau (Washington) is that it be a clearing house, an intelligence bureau, etc." Antecedently to the appearance of Dr. Klotz's paper in print, it was permitted me to read the manuscript and probably for this reason the impressions were lasting. It appealed to me from the very first and no less now as the adequate solution of the emergencies with which we, from time to time, find ourselves confronted. Klotz fancied it feasible to request all stations in the States to transmit their records to the Bureau for evaluation and comment. I am not quite agreed that this procedure is the most prudent. It might lead to the suspicion with many that they therewith forfeit their autonomy. The fact of the matter is that I have been so told by more than one director of a station to whom I mentioned this measure. Let then the stations be invited to despatch to the bureau their interpretations along with

the original gram or a ~~copy of the~~ same and ~~the promise~~ made that the gram and evaluation will be ~~returned with such~~ annotations as the committee sees helpful towards greater precision. After all what the bureau is looking for is the greatest available number of grams for comparison. Under such a cooperative system I cannot but figure to the salvage of much material which to date has been reconed on as useless. Besides, the reliable will be set in competition with the certain. We shall be enabled to ferret out much, hitherto a secret, regarding the effect of position of instruments, the instruments themselves on the grams, etc., thus transmuting anomolies into laws.

One more item and I have done. In order that seismograms be an asset to the literature of foephysics, they should be expressed in absolute units. This can only be had following standardization of instruments. No recognized authority exists in this country, as far as Iam aware, for such calibration. Such should be vested in the Central Bureau. Let its committee enjoy the right to classify stations on equipment, efficiency, etc., supervise all installations andprovide that constants be determined on a comon basis, at fixed time, and thelike. This done we might be saved the humiliation of much adverse criticism as has been directed at our plants in the past.

The time allotted me permits of my paper being a mere summary. You will readily supply for its deficiencies. In conclusion, I refer to the aphorism: "The proof of the pudding is in the eating thereof". Give the Bureau a trial. The seismogram, through it, will become the deus ex machina to solve more of the mysteries that lurk within the crust of the planet on which you and I breath and move.

Father F.A. Tondorf.

A LABORATORY MANUAL IN ZOOLOGY --- SUGGESTIONS.

In the March-April issue of the Bulletin there was submitted a sample of a laboratory manual in zoology with a request for criticism from Biology teachers. This brings up a very good question for discussion, for most teachers find it even more difficult to choose a suitable manual than to find a satisfactory text book, and that is hard enough. As the majority of us seem too hesitant to throw our hats into the ring on such occasions, the writer is going to offerhimself as a holocaust, to brook the barbs of his brethren, by submitting his opinions not humbly but boldly, to see if somehow a profitable discussion might be roused. So without further apology let us tread on some toes to see what excitement ensues.

The sample appearing on pp. 43-44-45 of the last issue is divided into six parts, the first three being Classification, Glossary and Description. The reason accounting for these three parts are all very good, however let us advance some arguments against them, and see what others think. Neither Classification nor Description belongs ~~to~~ in a manual at all, and the Glossary not as placed therein. The two former are found in the text, so why duplicate them? Let us keep the distinction between textbook and manual. The latter is a guide to the laboratory work, not a mine of information about the specimen. The chief idea in including them in the manual would seem to be to facilitate the preparation of the student. But there is such a thing as making it too easy. The student appreciates most what he works the hardest for. Let him consult his text and even reference books for the Classification and Description. To make sure that he will do so demand them of him in writing before class.

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A Glossary, of course, would seem to belong to a complete laboratory manual. However, in the private manuals used by so many professors in their own laboratories only, no glossary is needed. For practically all the more recent texts contain a complete glossary. Again then why duplicate? Let the student use his text book. But he won't take that trouble. Make him! His ticket of admission to the lecture hall of laboratory is a neat slip of paper with all the terms to be used in to-day's work. These he copied from a general glossary. He, or at least one in the class, had to read the lesson over to make the copy. Moreover, if a glossary as indicated in the present sample is given at the beginning of each section, either the same term must be repeated time and again, or it cannot be looked up if forgotten. Only a general glossary would be satisfactory, and if the text has that it ought to be sufficient.

With regard to the fourth point of the proposed manual, Procedure, the instructions submitted offer on theone hand a shining example of a laboratory "guide", but on the other hand fall into the very common error of not sufficiently explicit directions. To get the unpleasant part over first, let us see an example. "Identify head, thorax, abdomen". Not one word is given to guide the student. What characterizes these parts? What determines the limits of the thorax? The student must guess or else use previous knowledge. The sample cited, of course, is a very simple identification, but in a less familiar matter, my experience was that the student asked the instructor first, and then thrown back by a refusal onto his own resources, guessed.

Again, we read: Note legs, place and mode of attachment, different segments of which they are composed". "Mode of attachment", is entirely too vague. Not one student in ten would derive any profit from that. The manual should guide the student. Let it describe the mode of attachment, which the student must then verify and explain to the instructor. Otherwise all that the ordinary student notes is that the legs are attached and then goes ahead. "Different segments" is a great time-waster. It is next to impossible for a beginner to determine the segments of an insect's leg without some guidance, which is just what the laboratory manual is supposed to give. Tell him the mumber of the segments, with an idea of the comparative length of each. Then a boy of normal capacity can determine them in a short time without asking bothersome questions, and pass on to something else. He feels satisfied and encouraged. He got something by himself.

The first sentence of Exercise IV, describing an incision, is excellent. It is very definite. It tells what instrument to use and where. Many manuals cause the waste of much time and material by failing to give clear directions for incisions. Some teachers seem not to understand the full purport of a manual or guide. It is to guide first, last and always. For instance a laboratory guide in anatomy should never digress into the lecture field by describing habits or function. This view of the question is very well treated by Dr. Hyman in the preface of her Laboratory Manual of Comparative Vertebrate Anatomy (Univ. of Chicago Press), which is perhaps the best guide of any of the recent manuals that have appeared.

Whether Questions, Section 5 of the proposed manual, should be included or not is a matter I should like to se debated. At present I feel quite undecided on the point. The value of questions is beyond doubt, but whether they should be in the manual is open to discussion. Section 6, Bibliography, is an excellent idea as long as it

[illegible] of each section, either [illegible]
[illegible] it should be looked at [illegible]
[illegible] would be satisfactory [illegible]
[illegible] to be sufficient.
[illegible] "guide", but on the other [illegible]
[illegible] error of not sufficiently explicit [illegible]
[illegible] unpleasant part over first, let us [illegible] an example [illegible]
[illegible] abdomen." Not one [illegible] liver to [illegible]
[illegible] three parts? What determines [illegible]
[illegible] The student must guess of [illegible]
[illegible] of course [illegible]
[illegible]
Again, we read: Note legs, place [illegible]
[illegible] but our student [illegible]
[illegible] The usual [illegible] guide [illegible] explain
[illegible] of sternomastoid [illegible]
[illegible] a sentence of [illegible]
[illegible] It is very definite. [illegible]
[illegible] Many people [illegible]
[illegible]

is confined, as in our sample, to two orthree works that are suitable to the student and to which he has access. We are not dealing with research students, and hence have no need of a terrifying and exhaustive bibliography. What do others think on this subject?

Mr. John A. Pollock S.J.,
Woodstock, Md.

"Modern" PHYSICS.

Dear Father Editor, P.C.

In answer to the query which appeared in the last issue of the Bulletin concerning "modern" physics I would like to submit the following as it may be of interest and may invite criticism which will tend to the perfection of the course which we are obliged at present to follow. Last year, at St. Joseph's, Philadelphia, we worked under the old system. In the Premedical Course at Georgetown we follow the new system in the following way--- 3 hrs. of lecture, and 4 hrs. of laboratory per week.

MECHANICS.

Definitions, etc.
Composition and Resolution of Forces.
Types of Motion: definitions; uniformly accelerated motion; laws of motion; rotatory motion; oscillatory motion, the pendulum. The proof of all the formulae was required together with problems based on the formulae.
Equilibrium (not taken inclass but they were held responsible for it).
Work, power and energy.
Friction: Coefficient of friction; proof for angle of repose.
Simple machines: Mechanical advantage of each.

Molecular Forces and Motions.
Cohesion, Adhesion and Surface Tension.
Capillarity.
Pressure in Fluids.
Archimedes' Principle.
Density, Specific Gravity and the Properties of Gases, together with the instruments and machines which depend on these principles.

The final examination in Mechanics was held on Nov. 18, so we had about two months for the subject. We had two or three short examinations during the two months and now and then a quiz in which to work problems, etc. The mark in the final test was all that counted. You will notice that a number of things which we studied at Woodstock are omitted, e.g. stress and strain. We had a few experiments in stress and strain, also on the moment of inertia. How much they got out of it without having heard anything of these matters during lectures I do not know. Something had to go, and they went with others. Father Cullen thought them too important to leave out and so he gave them. As a result he finished mechanics about the middle of December. I think it would be a good thing to have some discussion as to what should be left out and what should be taken that the boys may get the most out of the two months work.

HEAT

Theories and Definition of Heat
Intensity Factor of Heat - temperature
Quantity Factor of Heat Energy, Measurement of Heat
Effects of Heat Energy:
- change of dimension;
  - solids, liquids and gases
  - absolute scale of temperature (derivation)
  - general gas law
- change in molecular state
  - fusion, vaporization
  - practical applications, liquification of gases, etc.
- atmospheric humidity

Transfer of Heat
- convection, conduction and radiation

Heat and Work
- mechanical equivalent of heat
- steam engine, turbine and gas engines.

The final examination was held on January 13. Two or three short tests were given during the treatise emphasizing practical and original problems.

SOUND

Wave motion, water waves, oscillation in waves
Proof for angle i = angle r in reflection
Refraction, proof for the index of refraction
Interference
Huyghen's Principle
Nature and Velocity of Sound
Pitch, loudness, quality
Foley's Sound Waves were shown for illustration.
Sound Production:
- tuning forks, velocity of sound with tuning fork;
- vibration of strings and wires. Laws of strings;
- frequencies in closed and open organ pipes.

Beats

The examination was held on February 10. The final examinations in mechanics, heat and sound were averaged together for the semester's work. Mechanics had two counts, heat and sound had each one. If a student's average was below 70, he failed in the first semester's work and had to take a condition in all three subjects.

LIGHT

Nature and Theories of Light
Velocity of Light, methods of determining the velocity
Illumination and Photometry, standards, law of inverse squares
Reflection of Light:
- proof for the position of the image in a plane mirror
- reflection from curved mirrors, proof for the formulae
- construction of images in mirrors
- spherical aberration

Refraction of light:
- laws of refraction and proof for Snell's law
- natural phenomena due to refraction

refraction through a prism, proof of the formula
total internal reflection
lenses, construction of images, formulae for focal length and for magnification

Spectra and color:
deviation of light through a prism
spectroscope
achromatic prism and lens
types of spectra
interference and the diffracting grating
Optical instruments, c amera, eye, etc. Defects of vision.
Polarization of Light

We did most of the problems in Smith (our text) on light right in the class. The examination was held on March 31.

ELECTRICITY

Just at present we are having the chemical effects of the electric current and we have about six more weeks of class. I hope to give everything that is in Smith, a brief outline of which would be:

Magnetism
Electrical Nature of Matter
Chemical Effect of the Electric Current
Ohm's Law and its Applications
Heating Effect of the Electric Current
Magnetic Effect
Magnetic Circuit
Induced Currents
Dynamo
Motors
Application of the Electron Discharge

I hope this survey may prove interesting to some of the readers and invite discussion as to what should be taken and what omitted in the shortened course. Personally I think that four hours of lecture with two hours of laboratory work instead of four would be better.

Mr. Thomas H. Moore S.J.,
Georgetown University.

THE AMERICAN CHEMICAL SOCIETY.

The American Chemical Society held its spring meeting this year in Baltimore, and due to the kind encouragement of Superiors our Province was well represented.

These meetings are most beneficial not only to ourselves personally but also to our respective colleges and so to the Society. They give us a very good idea of how chemistry is being taught in the most important colleges of the country, something which we could never learn from books, and they keep us informed of the recent developments in the science, v.g. Dr. Kendall of Columbia showed how the ionization theory has recently undergone a change.

They afford us a wonderful opportunity of learning the methods employed by different Professors and so aid us to improve our own teaching. For instance, Dr. Evans of Ohio State University explianed his method of teaching atomic structure, and Dr. Davidson of Brown gave a very fine demonstration of Lecture Table Experiments, which by the

way showed that this procedure is not dying out as some would have us believe. Professor Lowy gave us some valuable aids in teaching organic chemistry by showing how he uses charts and motion pictures, while in the corridors of the Chemistry Building at Johns Hopkins, where most of the meetings were held, we saw a very fine array of charts made by the pupils of the Notre Dame Sisters which depicted by means of drawings and samples various industrial operations, such as the extraction of iron, the manufacture of rubber articles, petroleum distillation, etc.

Moreover these meetings enable us to come into contact with the most important men in chemistry and consequently bring to their attention the fact that our colleges are not neglecting chemistry but are jsut as active as any other colleges in the country.

Mr. H.B. McCullough S.J.,
Woodstock College.

BACK NUMBERS WANTED.

As the chemists at Woodstock are very anxious to complete their set of the publications of the American Chemical Society, they would appreciate it very much if some one of Ours could send them the following two numbers of the JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY, viz. January 1922, and August 1924. Any one who is able to secure an extra copy of these two issues will confer a great favor by sending them to Mr. H.B. McCullough S.J., Woodstock College.

SOME FRENCH SCIENTIFIC INSTRUMENT MAKERS.

French scientific instrument makers in the past always enjoyed a good reputation for the workmanship and finsih of their instruments. Some of the older apparatus used for many years at Woodstock gives evidence of their skill. However it is probably true that shortly before the war most of the apparatus imported into this country from abroad came from Germany. We need not discuss the reasons for this fact. It was certainly not due to any inferiority of design or construction in instruments made in other countries. There is no reason to suppose that for example the Frence instrument makers are in any way inferior to their predecessors. Although it is now necessary to pay duty on all importations the value of the franc may make it worth while to import some things from France. French dealers may of course raise their prices with the changein the franc but in American money they will doubtless be lower than usual. A few years ago when the mark was very low though it had not yet begun to depreciate to almost nothing Max Kohl of Chemnitz, Germany, ignored it completely in fixing his prices. He simply added 20 per cent to his pre-war prices as expressed in English or American money. Prices now are doubtless expressed in gold marks which have about the pre-war value. The following list of French scientific instrument makers was sent to us some time ago by Father Teilhard de Chardin the able paleontologist of the Province of Lyons who now lectures on Geology at the Catholic ~~University~~ Institute of Paris. We give it here as it may prove useful to some of our readers. Before making out any order it would be well to send for a catalogue or price list.

<u>Apparatus for General Physics</u>.

Roger-Ducrétet, 75 rue Claude-Bernard, Paris.
G. Massiot, 15 Boulevard des Filles du Calvaire, Paris.
J. Lancelot, 70 Avenue du Maine, Paris. (Acoustics only)
J. Richard, 10 rue Halévy, Paris. (specialty, registering apparatus)
Pellin, 5 Avenue d'Orleans, Paris. (" pyrometry ")

Jobin, 31 rue Humbolt, Paris. (specialty, spectroscopy)
Thurneyssen, 58 rue Monsieur-le-Prince, VI, Paris. (Vacuum Tubes)
Prin, 56 Boulevard Arago, Paris. (Optics)
Carpentier, 20 rue Delambre, XIV, Paris. (Electrical Meters)
Berlemont, 24 rue Paschal, Paris. (Glass Work)
Morin, ~~2~~ 11 rue Dulong, Paris. (Mathematical Instruments)
Baudin, 276 rue St. Jacques, Paris. (" ")

X-Ray, High Voltage, High Frequency Apparatus.
C. Ropiquet, Hazart, et Roycourt, 71 Avenue d'Orleans, XIV, Paris.
Gallot et H. Pilon, 9 rue Mechain, XIV, Paris.

Radio Apparatus and Accessories.
Société des Telegraphes Multiplex, 57 rue de Vannes, XIV, Paris. (Receiving apparatus especially for amateurs, amplifiers)
Société Independante de Telegraphie snas Fil, 66 rue La Boétie, VIII, Paris. (Receiving and Sending Sets)
La Précision Electrique, 10 rue Croce-Spinelli, XIV, Paris. (Air Condensers and Wave Meters).

PUBLICATIONS.

The Grolier Society of New York has recently published "The Book of Popular Science" in fifteen volumes. As its title indicates it is a popular encyclopedia of pure and applied science with biographical sketches of prominent men of science. It has a number of illustrations. It may be noted that this is not an entirely new work, but is a revision of an older work. Among the collaborators we notice the names of Father William F. Rigge of Crieghton University, and Fathers E.C. Phillips, H.M. Brock and J.A.S. Brosnan of Woodstock College.

Our attention has recently been called to an able article by Mr. F.W. Sohon which appeared in the BULLETIN of the Seismological Society of America for Sept., 1924. We are indebted to the Seismological Observatory of Fordham University for a copy. It is entitled "A Graphical Determination of the Actual Amplitude of the Earth's Motion from Seismological Data". We offer the author our belated congratulations.

Mr. J.S. O'Conor the successor of Mr. Sohon at the Fordham Seismological Observatory has an interesting article in AMERICA, May 9, on "Trapping an Earthquake".

The PHYSICAL REVIEW, May 1925, contains an abstract of a paper read by Father J.B. Macelwane of the Missouri Province at the March Meeting of the American Physical Society at Pasadena, Cal. The title is "New Evidence for a Sharply Bounded and Very Rigid Core in the Earth". Father Macelwane is an able seismologist and we understand that he has been lecturing for the past two years on his specialty at the University of California since taking his doctor's degree there.

The GENERAL SCIENCE QUARTERLY for May contains in somewhat abbreviated form the lecture of Father H.M. Brock of Weston recently given at Boston College before the Eastern Association of Physics Teachers on "Some Properties of the Thermionic Vacuum Tube".

DEATH OF FATHER CORTIE.

The daily press recently reported the death of Father Aloysius Cortie at the age of 66. He was director of the Stonyhurst Observatory, having been associated there for many years with Fathers Perry and Sidgreaves. He was well known as an astronomer, writer and lecturer. He attended a meeting of the Astronomical Union at Mount Wilson about 1910. He also attended last Summer's Meeting of the British Association

at Toronto. On his return home he visited several houses of our Province.

REGENERATING OLD TYPEWRITER RIBBONS.

Some of our readers may be interested to know how they may re-ink old typewriter ribbons. I have found the following method to work very satisfactorily. Simply roll the ribbon tightly onto its spool, put it into its tin box, and then put about five drops of good machine oil onto it (e.g. three in one oil). Then cover the box and leave the ribbon untouched long enough to allow the oil to spread. Three or four weeks should generally be long enough. It is taken for granted that the fabric of the ribbon is still in good condition and that the only trouble is that the ribbon is dry.

SCIENCE SUMMER SCHOOL AND ANNUAL CONVENTION.

The Science Summer School will be held this year at Holy Cross College, Worcester, Mass., beginning July 21. The Fourth Annual Congress of our Association will be held at the same place on August 12 and 13. Further details will be sent to each member in a circular toward the end of June. The sectional programmes are well in hand and an interesting and profitable session is assured.

With this issue the Bulletin completes another very encouraging and successful year. Our heartiest thanks are hereby extended to all of those who have in any way contributed to this success,---to those who so generously supplied matter for publication, as well as to the Woodstock theologians who have attended to the printing and the mailing. True, the work is naturally rather unattractive and disagreeable, but a stimulus is had from the consciousness that one is laboring for a worthy purpose and that others are being benefited by such efforts. May our next year be even more successful and gratifying.

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L. D. S.